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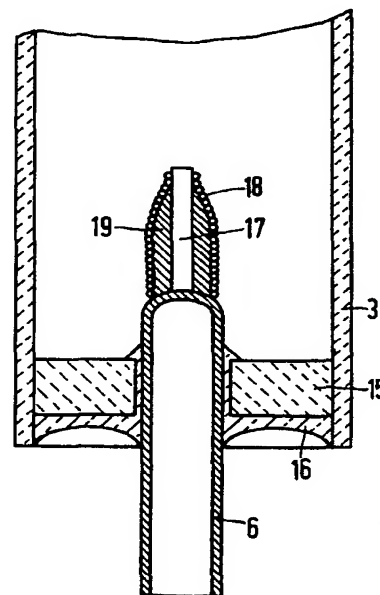
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⑤ High-pressure sodium vapour discharge lamp.

⑤ In a high-pressure sodium vapour discharge lamp according to the invention, an emitter (19) is used which comprises strontium yttrate. It has been found that the lamp has a comparatively long life. This becomes clearly manifest in a low-power lamp which during operation emits «white» light.



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"High-pressure sodium vapour discharge lamp".

The invention relates to a high-pressure sodium vapour discharge lamp provided with a lamp vessel sealed in a vacuum-tight manner and containing sodium, mercury and rare gas, while current supply conductors are passed through the wall of the lamp vessel to a pair of electrodes having a strontium-containing emitter.

Such a lamp is known from British Patent Specification 2,051,470 (PHN 9472). The known lamp is constructed so that it emits during operation substantially "white light", i.e. light having a colour temperature lying between approximately 2250 and approximately 2750 K and a general colour rendition index R_g lying between approximately 60 and approximately 85. The emitter of the electrodes contains oxygen-bound strontium and oxygen-bound tungsten in a molar ratio of 3 to 50. This emitter is used in the known lamps because such an emitter counteracts the extraction of sodium from the discharge.

In high-pressure sodium vapour discharge lamps producing "white light", the temperature of the sodium amalgam in the lamp is higher during operation and sodium is extracted from the discharge at a higher rate than in high-pressure discharge lamps emitting gold-coloured light. This can be explained in that chemical reactions forming sodium compounds and thus extracting sodium from the discharge proceed more rapidly as the temperature in the lamp is higher.

The temperature of the sodium amalgam in high-pressure sodium lamps also increases as their power is lower. This is due to the smaller dimensions of low-power lamps. The temperature of the sodium amalgam in a high-pressure sodium lamp of 50 W emitting "white light" is approximately 1200 K.

In the known lamps, the extraction of sodium is counteracted by the use of the said emitter. However, it has been found that in lamps producing "white light" having a very low power, for example 50 W, and hence at high temperature, sodium is still extracted from the discharge at such a high rate that the lamps have a life too short for practical use.

The invention has for its object to provide a high-pressure

sodium lamp which, even if it is designed to emit "white light" at very low power, has a longer life sufficient for practical use.

According to the invention, this object is achieved in a high-pressure sodium vapour discharge lamp of the kind mentioned
5 in the opening paragraph in that the emitter comprises strontium yttrate.

It has been found that the lamp according to the invention, even if it is designed so that during operation very high temperatures prevail in it, such as, for example, a lamp generating "white light"
10 and consuming 50 W, has a considerably longer life sufficient for practical use. The end of the life of high-pressure sodium lamps is attained when the voltage across the lamp has increased to such an extent that the lamp extinguishes or, in lamps designed to emit "white light", when the colour point of the emitted light shifts
15 to outside the range in the colour triangle within which the light is "white". Both this shift of the colour point and the increase of the lamp voltage are caused by the fact that the ratio Na/Hg in the filling of the lamp decreases as a result of sodium being extracted from the filling.

20 The range in the colour triangle within which the light of a high-pressure sodium lamp is called "white" is bounded by the lines $x = 0.460$, $x = 0.495$, $y = 0.408$ and $y = 0.425$. According to more stringent standards based on the better acceptance of the light as "white light" by subjects tested, the range in the colour triangle
25 within the light is called "white" is bounded by the lines $x = 0.468$, $x = 0.490$, $y = 0.408$ and $y = 0.425$. The colour temperature then lies between about 2300 and about 2700 K and the general colour rendition index R_a lies between about 70 and about 85.

The high-pressure sodium lamp according to the invention
30 is obtained inter alia by immersing electrodes in a suspension of SrCO_3 and Y_2O_3 . After they have been dried, the electrodes are heated to form the emitter in situ. A heating at about 1600°C for a few, for example two, minutes in vacuo or in a inert gas is sufficient to this end. The emitter has the advantage that it is highly resistant
35 to the action of moisture so that electrodes provided with the emitter can be manipulated in contact with the prevailing atmosphere.

In the formation of the emitter, instead of strontium carbonate another strontium salt, such as the formate may be utilized

or, for example, strontium hydroxide or peroxide may be used. A further possibility is to use a number of stontium compounds.

The lamp according to the invention mostly has a ceramic lamp vessel, i.e. a lamp vessel of mono- or polycrystalline material, such as, for example, aluminium oxide. The lamp vessel may have, if the lamp has to emit "white" light, a gas filling containing a sodium amalgam whose weight ratio Na/Hg is 1-1/9, while the pressure of the rare gas, for example xenon and/or argon and/or neon, at 300 K is $1.3 \times 10^3 - 1.3 \times 10^5$ Pa. The sodium pressure during operation is then $4 \times 10^4 - 10.7 \times 10^4$ Pa.

An embodiment of the lamp according to the invention will now be described more fully with reference to the drawing and the example. In the drawing:

Fig. 1 is a side elevation of a high-pressure sodium vapour discharge lamp partly broken away;

Fig. 2 is a longitudinal sectional view of an end of the lamp vessel of Fig. 1.

In Fig. 1, a ceramic lamp vessel 3 sealed in a vacuum-tight manner is arranged in a glass outer bulb 1 provided with a lamp cap 2 and between current supply conductors 4 and 5.

Niobium sleeves 6 and 7 conduct the current through the wall of the lamp vessel to the electrode pair. The current supply conductor 5 is passed with a certain amount of clearance into the niobium sleeve 6. A good electrical contact between these two parts is guaranteed by a Litze wire 8.

A vacuum, which is maintained by the barium getter evaporated from the ring 9, prevails in the outer bulb. A glow starter 10 is arranged in the outer bulb in series with a bi-metal switch 11, which together shunt the discharge path in the discharge vessel 3. Upon ignition of the lamp, a glow discharge is obtained in the glow starter 10. After this glow discharge has been extinguished due to increase in temperature in the glow starter, a voltage pulse is produced across the discharge vessel 3, which causes the lamp to ignite. The heat emitted by the discharge opens the bi-metal switch 11.

In Fig. 2, the lamp vessel 3 is sealed at its end by a ring 15 of ceramic material. A niobium sleeve 6 is passed through the ring 15 and is connected to it by a melt connection material 16, for example consisting of 32.6% of Al_2O_3 , 50.4% of CaO, 4.2% of BaO, 10.3% of MgO,

0.1% of SrO , 1.8% of B_2O_3 , 0.5% of SiO_2 , 0.1% of Na_2O or of 20.1% of Al_2O_3 , 69.4% of CaO , 6.0% of BaO , 3.5% of MgO , 1.0% of B_2O_3 ($\% = \text{mol.}\%$).

The sleeve 6 has welded to it a tungsten electrode 17, onto which a tungsten wire 18 is wound which surrounds an emitter 19.

5 Example.

In a practical case, a discharge vessel has an inner diameter of 3,5 mm and an inner length of 25 mm. The distance between the tips of the electrodes was 15 mm. 2 mg of emitter was provided on each of the electrodes in the cavities of the wire turns. The discharge vessel contained 10 mg of sodium amalgam with a ratio Na/Hg of 0.375 and xenon up to a pressure of 10^4 Pa at room temperature. During operation the lamp consumed a power of 50 W.

Such lamps provided with different emitters were tested according to the schedule: 5.5 hours "on", 0,5 hour "off". It has been found that the lamps tested according to this schedule reach the end of their life after a smaller number of hours in operation as a result of an increase of the lamp voltage than with the use of the schedule 0.5 hours "on", 0.5 hours "off" or with continuous operation.

In a first series of lamps (I), electrodes were used which were immersed in a suspension of 290 g of SrCO_3 , 220 g of Y_2O_3 , 100 ml of monoethylglycol ether, 60 ml of butylacetate and 5 g of cellulose nitrate.

The electrodes were dried and were then heated in vacuo for 2 minutes at 1590°C . Sr_2O_4 was then formed.

For comparison, in a second series of lamps (II), electrodes were used to which a suspension of 155 g of SrCO_3 , 55 ml of ethylglycol, 23 ml of ethyl alcohol, 5 ml of butylacetate and 1.5 g of nitrocellulose was applied. After the suspension has been dried, the electrodes were heated in vacuo for 2 minutes at 1450°C . The molar ratio of Sr and W in the emitter was about 10.

The experimental results with these lamps are stated in the following table.

TABLE

Series	V_{1a} (V)	x,y	V_{1a} (V)	x,y	life L (hr)	
	after 100 hr		after .. hr			
I	81 0.483; 0.418		88	0.486; 0.414	3000	L 3000
II	85 0.477; 0.417		89	0.487; 0.411	1500	1500 < L < 2000

V_{1a} = voltage across the lamp.

In this experiment, the criterion was applied that, when the colour point of the emitted light from 50% of the number of lamps tested arrives outside the region bounded by the lines $x = 0.468$, $x = 0.490$, $y = 0.408$ and $y = 0.425$, the end of the life is reached.

The lamps of series I were measured after 3000 operating hours. Out of seven lamps utilized, five lamps has a colour point in the said range. The average value of the colour point of these five lamps is indicated in the table. The experiment was terminated at that instant.

The lamps of series II were measured after 1500 operating hours. Out of nineteen lamps utilized, thirteen were then left having the average colour point stated in the table. After 2000 operating hours, only four lamps were left.

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A high-pressure sodium vapour discharge lamp provided with a ceramic discharge vessel sealed in a vacuum-tight manner and containing sodium, mercury and a rare gas, while current supply conductors are passed through the wall of this lamp vessel to an
5 electrode pair which has a strontium-containing emitter, characterized in that the emitter comprises strontium yttrate.

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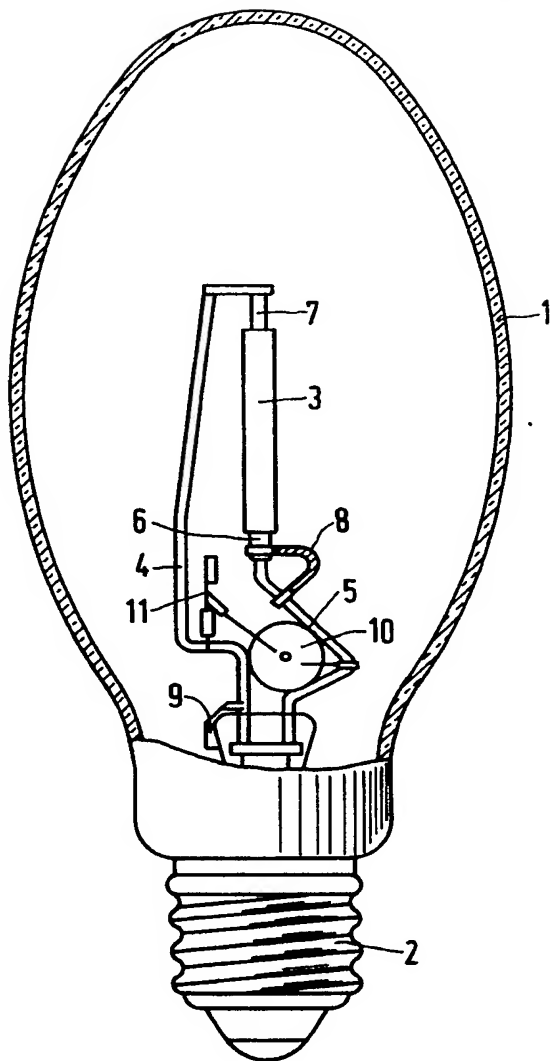


FIG. 1

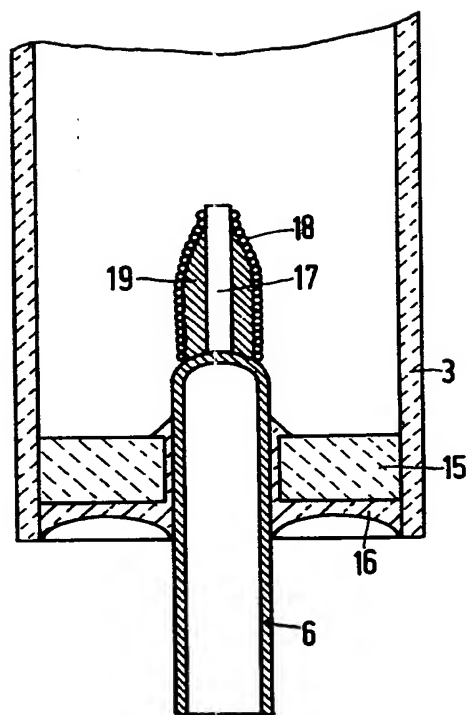


FIG. 2

PHN 10991

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European Patent
Office

EUROPEAN SEARCH REPORT

Application number

EP 85 20 0448

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE-A-2 951 741 (MITSUBISHI DENKI K.K.) * Page 12, paragraph 2 - page 16, paragraph 2; page 24, paragraph 2 - page 30, paragraph 1 *	1	H 01 J 61/073
X	--- PATENTS ABSTRACTS OF JAPAN, vol. 5, no. 141 (E-73)(813), September 5, 1981, page 145 E 73; & JP - A - 56 78057 (MITSUBISHI DENKI K.K.) 26-06-1981 * Whole abstract *	1	
D,A	--- GB-A-2 051 470 (PHILIPS) * Page 2, lines 19-99; figures 1,2 *	1	
A	--- FR-A-2 316 725 (PHILIPS) * Page 3, line 24 - page 4, line 19 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) H 01 J 61/00

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 01-07-1985	Examiner SARNEEL A.P.T.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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